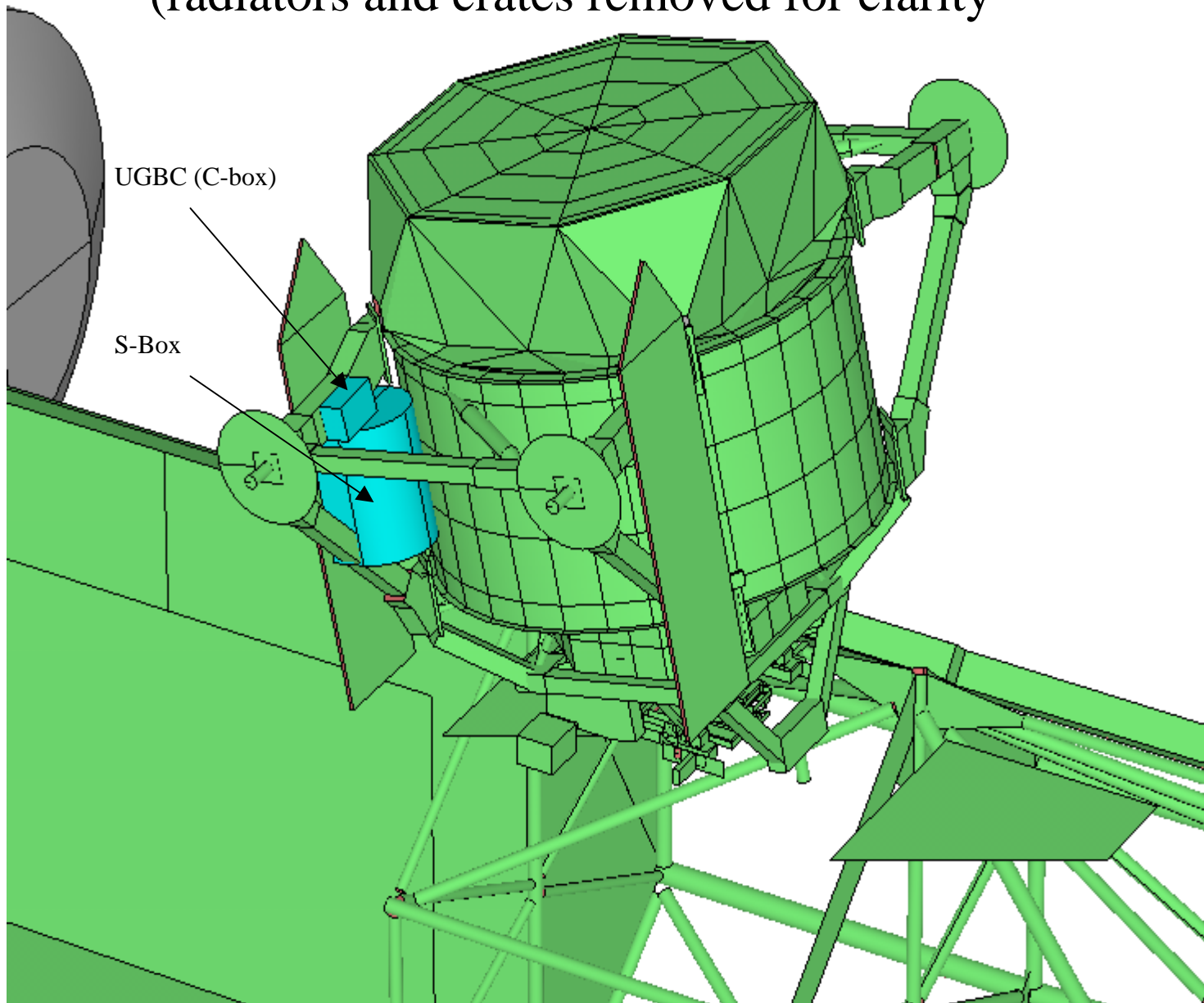


AMS-02 TRD Gas System Thermal

TRD Gas System Overview

- **TRD Gas System provided a mixture of Xenon and CO₂ to the TRD detector.**
- **System consists of two “boxes”:**
 - **Supply Box (S-Box) includes a Xenon tank, a CO₂ tank, mixing tank, valves, pressure sensors, etc.**
 - **Control Box (C-box) includes a pump, valves, sensors, etc.**
- **S-box components are attached to a large aluminum support plate which attaches to the USS-02.**
- **C-box support structure attaches to the USS-02 and to the S-box support plate.**
- **Both boxes are enclosed in an MLI blanket**

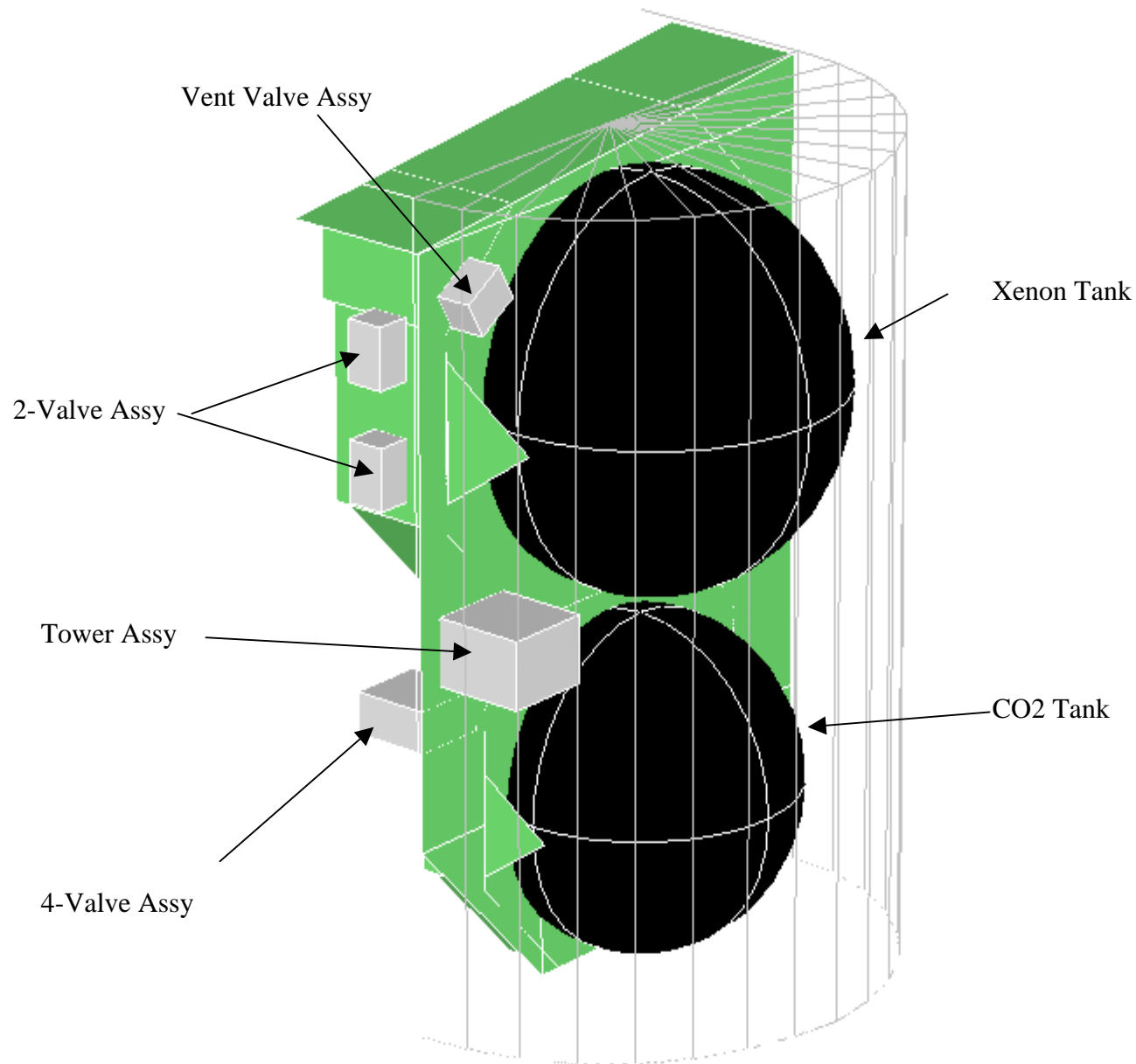
TRD Gas System on AMS-02 (radiators and crates removed for clarity)



S-Box Description

- The Xe and CO₂ tanks are attached to the support plate via spherical bearing
- Valves and sensors are ganged together in brackets which are thermally isolated from the support plate via G10 spacers.
- Each valve group and each tank is wrapped in a secondary MLI enclosure.
- Local thermostatically controlled heaters are attached to each valve group and tank.
- Persistent heaters attached to the tank bosses to minimize gradients in the tank.
- Power dissipation is based in pressure sensors and include 3.4W on the Tower Valve group and 2.4W on the upper 2-valve group.

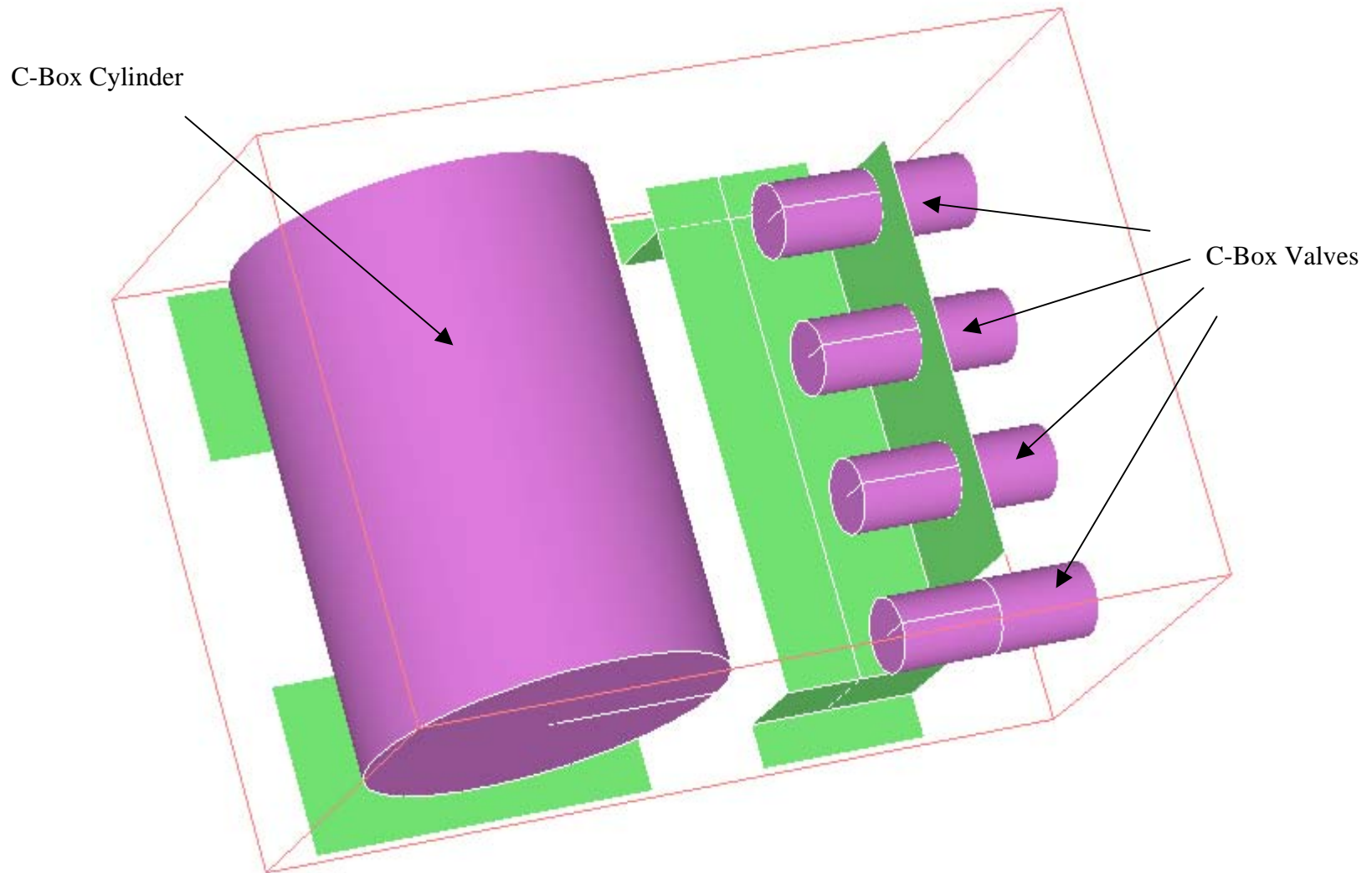
S-Box



C-Box Description

- **The C-box consists of a centrifugal pump, enclosed in a pressurized canister, and a group of valves attached to a support bracket.**
- **Thermostatically controlled heaters are attached to the pump canister and each valve.**
- **The pump dissipates 3.6 watts of heat.**
- **The C-box is also enclosed in an MLI enclosure.**

C-Box



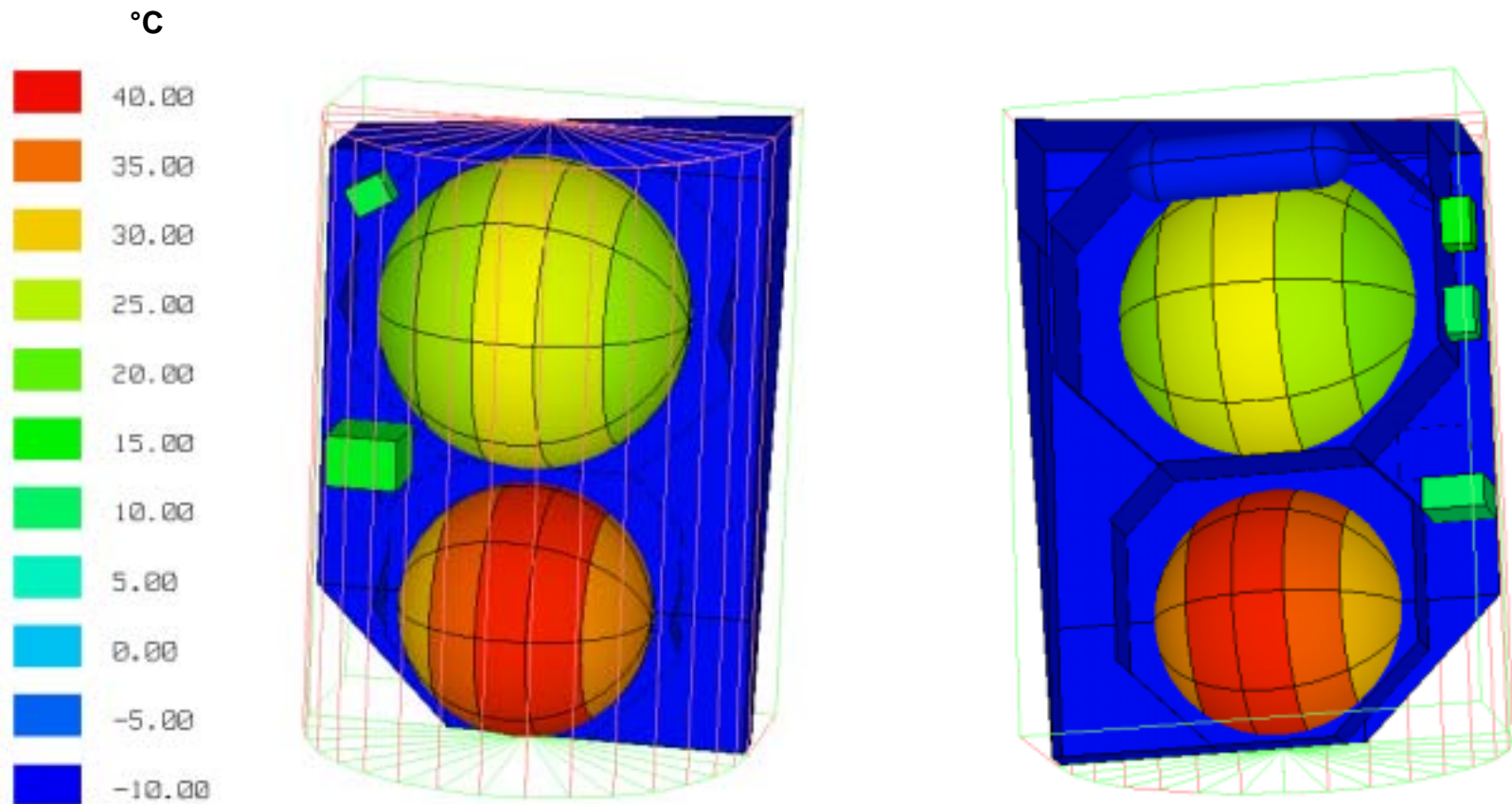
Thermal Requirements

- Thermal limits for valves, pressure sensors, etc is +5° to +55°C
- The pump has a limit of 0° to +40°C.
- The Xe and CO₂ tanks must be above their critical temperature in order to measure remaining gas. Time constants are so large that these tanks should be maintained warm at all time.
- The Xe tank requirement is +20° to +65°C
- The CO₂ tank requirements is +34° to +65°C

Analysis cases

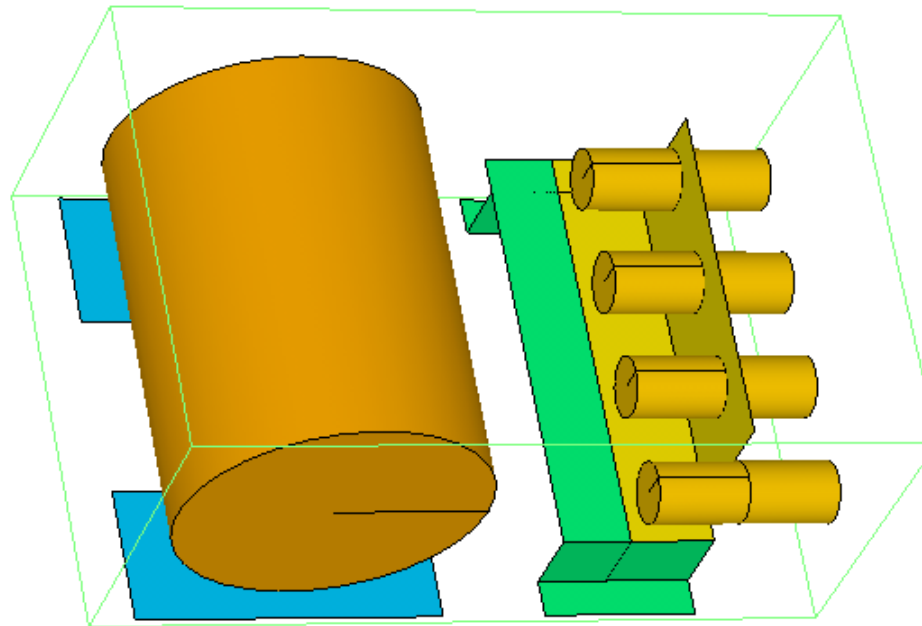
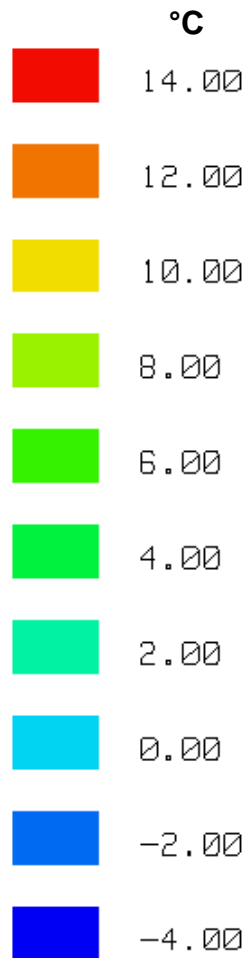
- TRD Gas system was analyzed using an integrated AMS-02/ISS thermal model.
- Previous attitude surveys were used to identify worst case hot and cold attitudes for the TRD Gas Box.
- Cold case ISS attitude:
 - Yaw/Pitch/Roll (YPR)=-15°, +15°, -15°; beta = 0°
- Hot case ISS attitude:
 - YPR = -15° -20°, -15°; beta=+75°

Cold Case (with heaters)



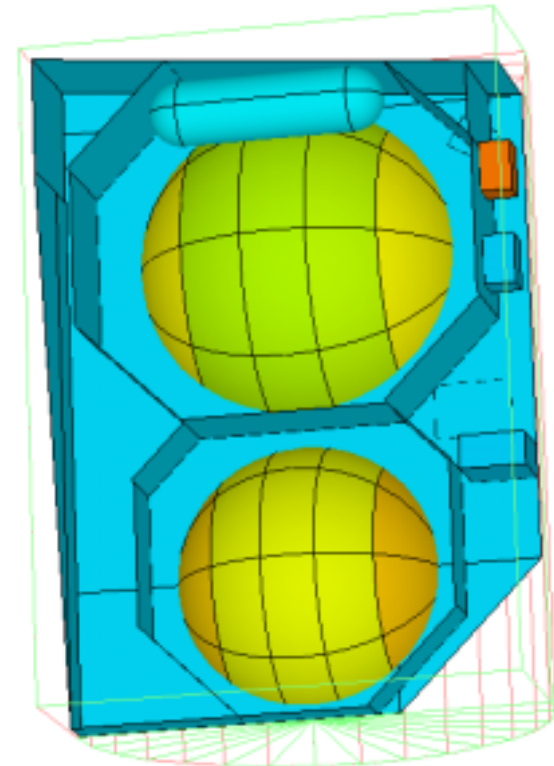
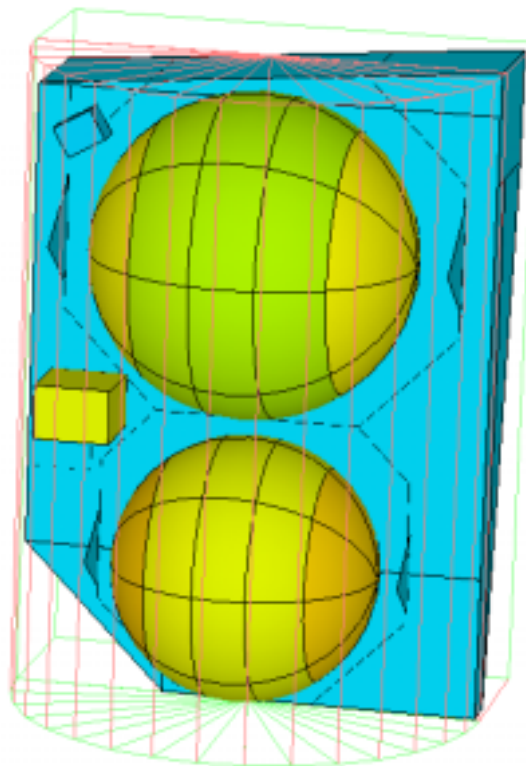
S-Box

Cold Case (with heaters)



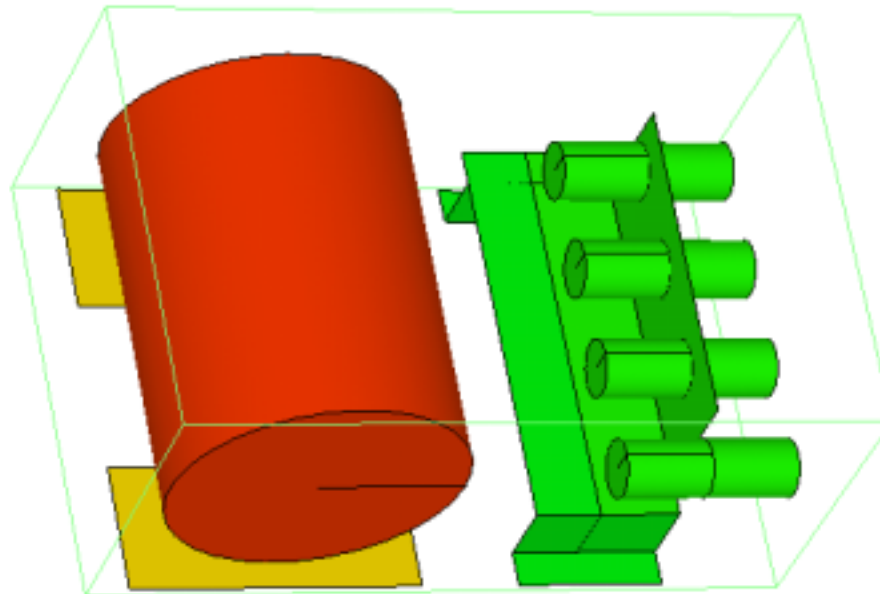
C-Box

Hot Case



S-Box

Hot Case



C-Box

Heater Status

Component	Node	Low Limit	High Limit	Power	Heater	Set On	Set Off	DutyCycle	Avg Pow
	Number	deg C	deg C	Watts	Watts	deg C	deg C	(cold case)	Watts
Xe Tank	1001-1040	20	65		8	26	28	0.394	3.15
Xe Tank boss 1	1001	20	65		1	26	28	1	1.00
Xe Tank boss 2	1005	20	65		1	26	28	1	1.00
CO2 Tank	2001-2040	34	65		12	39	41	0.333	4.00
CO2 Tank boss 1	2001	34	65		1	39	41	1	1.00
CO2 Tank boss 2	2005	34	65		1	39	41	1	1.00
Tower Bracket	6100	5	55	3.40	6	10	15	0.424	2.54
2-Valve, upper	6200	5	55	2.40	3	10	15	0.424	1.27
2-Valve, lower	6300	5	55		7	10	15	0.394	2.76
4-Valve	6400	5	55		11	10	15	0.606	6.67
Vent Valve	6500	5	55		4	10	15	0.515	2.06
C-Box Can	920	0	40	3.60	10	10	15	0.576	5.76
C-Box Valves	950-980	5	55		4	10	15	0.515	2.06
TOTAL				9.40	69				23.12
* +5W for 1 hr/day									

Summary

- **All TRD Gas minimum temperature requirements are met with the assumed heater configuration.**
- **Hot case analysis also shows all components below their high temperature limits. Pump located in C-Box cylinder is marginal.**
- **Thermal vacuum testing will be performed to verify thermal design.**

TRD Gas System Thermal Design

Circulation Box:

10 W Foil heaters for the Can
3.6W Cont +5W 1hr/day
4 W foil heaters for Valves
(+MLI Enclosure)

2 Valve GP50 Bracket:

3W Resistors
2.4W Cont. P-Sensors
(+MLI Enclosure)

2 Valve Filter Bracket:

7 W Resistors
(+MLI Enclosure)

4-Valve Bracket:

11 W Resistors
(+MLI Enclosure)

Tower Bracket:

6W Resistors
3.4W cont. P-Sensors
(+MLI Enclosure)

Vent Valve Bracket:

4 W Foil heaters
(+MLI Enclosure)

Xe Vessel Heaters:

8 W foil heaters
2 W boss heaters
(+MLI enclosure)

MLI Outer Covering

-Encloses
Complete
System-
(only partial shown)

CO2 Vessel Heaters:

12 W foil heaters
2 W boss heaters
(+MLI enclosure)